

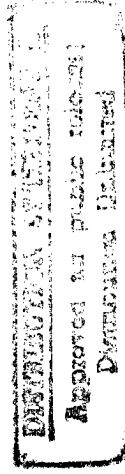
FINAL SUBMITTAL EXECUTIVE SUMMARY

FORT A.P.HILL

ENERGY ENGINEERING ANALYSIS PROGRAM

CONTRACT NO. DACA65-81-C-0021

for the NORFOLK DISTRICT
CORPS OF ENGINEERS



prepared by

MMM  **DESIGN GROUP**

A PROFESSIONAL CORPORATION
ARCHITECTS + ENGINEERS + PLANNERS
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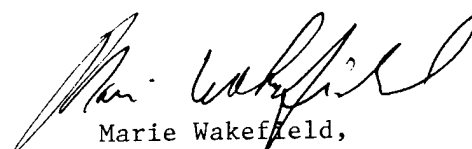


DEPARTMENT OF THE ARMY
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IV EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 OBJECTIVE

This is a summary of an Energy Engineering Analysis, conducted to provide a Basewide Energy Savings Plan at Fort A. P. Hill, Virginia. This Plan includes recommendations for energy conservations Projects to reduce the installation's present energy consumption, as well as a description of other energy-related factors which affect consumption. It is important to note that savings figures presented in this summary can only be realized after all Projects have been implemented. MMM Design Group has developed Projects that meet the funding requirements for the D.O.D.'s Energy Conservation Investment Program. Furthermore, the recommended Projects provide compliance with the Army Facilities Energy Plan. This summary presents data relative to the following chronological period:

- A. 1975 Energy Consumption (baseline).
- B. 1985 Energy Use (projection).

1.2 METHODOLOGY

The analysis methodology was based in part on an examination and study of a "sampling" of structures representative of all of the structures at Fort A. P. Hill. These "sample" or "study" buildings were used to model "building use groups" which had similar architectural, mechanical, and electrical system characteristics, as well as similar functional uses. These characteristics are summarized in Figures 1, 2, and 3.

2. EXISTING ENERGY CONSUMPTION

Once these building group system characteristics were determined, they were input into the Corps of Engineers Building Loads Analysis and Systems Thermodynamics (BLAST) Program. Then, the BLAST Program parameters were manipulated in order to simulate 1975 conditions. See Building Group Energy Usage (Figure 4) for a description of energy sources,

and energy use totals by building group. Finally, a total MBTU consumption record was prepared to model actual consumption between 1975 and 1980, adjusted for historic degree days, (Figure 5). This figure reflects a total consumption of 75,000 MBTU for the 1975 baseline, and 86,000 MBTU for 1980. This record includes energy use for buildings and all other energy consuming systems (site utilities, site lighting, etc.).

Figure 6 compares the relative percentages of fuel types used during the 1975 and 1980 fiscal years. Noteworthy is the fact that fuel oil use has declined, from 51% to 40% of the total energy usage. Liquid petroleum use has increased slightly from 7% to 8%. The fuel oil usage drop has been made up by electricity usage, which has increased significantly from 42% to 52% of the total energy consumed.

Figure 7 indicates the annual source energy consumed by each of the significant building groups used in the basewide energy model. Dining is the largest user, consuming 30% of total energy, housing the second largest consumer at 23%, and administration at 22%. Latrines and shop facilities use 12% and 10% respectively. Utilities use approximately 3%.

3. ENERGY CONSERVATION MEASURES DEVELOPED

3.1 Introduction

The tool used for initial analysis of possible new energy conservation measures or options at Fort A. P. Hill was a Preliminary Matrix (Figure 8). This matrix ranked each option by building use group, and established priorities for detailed study and project development of selected options.

The separately bound "Appendix" volume of this Energy Engineering Analysis provides documentation of the back-up material developed during the course of the work. The results of the programmed energy conservation Projects are included in the separately bound volume entitled "Project Documentation." A summary of all Projects, categorized by EEA study Increment, can be found in the EEA Project Summaries (Figures 9 through 12). These projects are listed in order of their E over C Ratio.

3.2 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENTS (A) AND (B)

A total of eight (8) projects, Increments (A) and (B), qualified under ECIP criteria as programmable energy conservation projects. Included are the installation of programmable thermostats for night setback of heating and cooling systems, as well as noncombustible insulation for building envelopes. Also qualifying for these increments are the caulking and weatherstripping of building fenestration, the replacement of inefficient building and street lighting, and the installation of storm windows.

3.3 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (G)

A total of four (4) Projects did not meet the necessary ECIP criteria, and therefore do not appear in the Project Documentation volume of this report. These projects were subsequently classified under Increment (G). Included under this increment are the installation of insulated overhead doors, timer switches for toilet room lighting and domestic water heater controls. Also included is the installation of a basewide Energy Management Control System (EMCS).

3.4 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (C)

Several options were analyzed for potential renewable energy projects (Increment C). Included in this part of the study is a solar domestic water heating system, an active solar application. Trombe wall adaptations are presented as a passive solar application, and wood boiler conversions are analyzed as a renewable energy source. Of these projects, only the wood boiler conversion appears to be a candidate for further feasibility analysis. These projects are described further in Section 3.11 of the Report Narrative, and back-up calculations are presented in Section 9 of the Appendix.

3.5 RECOMMENDED ENERGY CONSERVATION PROJECTS: INCREMENT (F)

Recommendations for modifications to system operation at Fort A. P. Hill, which are within the funding authority and/or management control of the Facilities Engineer, fall into four broad categories.

- A. Replacement of "as-needed" system components with "state-of-the-art", high-efficiency components: Such components as electrical lamps, water system pump motors, and high-bay roll-up doors, are examples of opportunities to save energy by means of Facility Engineer selection and purchase procedures.

- B. Elimination of unnecessary energy consuming items: This proposal requires coordination with current and programmed building use. Involves the elimination of domestic hot water in Administration buildings, and the reduction of window glazing where not required for natural light, ventilation or egress.
- C. Controls of energy systems: This suggestion includes miscellaneous installations of photocell and time clock controls for lighting, selective switching of lighting and domestic hot water circulating pump controls.
- D. Future Metering Plan: Provided for the future monitoring of electricity consumption, this plan determines the high energy use buildings on base and suggests locations for future electrical meters.

The above recommendations are discussed in more detail within the body of the Report Narrative.

4. ENERGY AND COST SAVINGS

The annual energy savings by proposed Project are given in Figures 9 through 12, along with the payback period, in years. This payback is based on the implementation of all Projects by fiscal year 1985, and uses fuel types related to each respective project. Fuel cost escalation is given from 1980 to 1985 in Figure 13, entitled "Energy Cost Projection."

For projected energy consumption and total energy savings to be realized, savings from inter-related or interdependent projects must be coordinated. Thus, the total energy savings, as shown in the Energy Projection Summary (Figure 14), is based on the assumption that all projects will be implemented by a given fiscal year (1985).

5. ENERGY PLAN

A Fort A. P. Hill Basewide Energy Savings Plan, the ultimate result of this Energy Engineering Analysis, includes energy use input from the following:

- A. Past Energy Conservation Projects.
- B. Energy Conservation Projects Under Contract.
- C. Existing Operational and Maintenance Projects.
- D. Demolition and Shutdown.
- E. New Construction Projects.
- F. Recommended Energy Conservation Projects.

A summary of the above energy use factors is given in Figure 14, the Energy Projection Summary, with the exception of Increment C and Increment G energy savings, as well as savings from several Increment F projects which could not be projected. (See Figure 12).

Past and ongoing energy conservation projects, along with those projects recommended by this energy engineering analysis, account for a 34% reduction in FY 1975 energy consumption. However, the sum of new construction, decreased winterization and increased building air conditioning results in a 32% increase in energy consumption. This increase almost completely offsets the savings achieved by energy conservation projects. The final result of the savings plan, as seen in Figure 14, is an overall 2% decrease in annual energy consumption by FY 1985.

A more appropriate method of evaluating this basewide energy savings plan is through the analysis of energy usage per square foot of building area. In base year 1975, Fort A. P. Hill contained approximately 522,000 square feet of building area, yet consumed over 75,000 MBTU annually. This equates to an annual consumption of approximately 144,000 BTU per square foot. By FY 1985, with the recent construction and programmed construction projects included, building area on the Fort will increase to over 960,000 square feet. As shown in Figure 14, however, annual energy consumption is projected at only 73,700 MBTU for that year. This results in an annual energy usage of only 76,700 BTU per square foot of building area, or a 53% reduction.

<u>BUILDING USE-GROUP</u>	<u>SUB- GROUP NO.</u>	<u>STUDY BUILDING NO.</u>	<u>WALL CODE</u>	<u>ROOF CODE</u>	<u>EN. SYS. CODE</u>	<u>TOTAL SUB-GROUP SQUARE FEET</u>	<u>TOTAL USE-GROUP SQUARE FEET</u>
Administration	A-1	101/126/214	WD	PS	AB	123,270	170,838
	A-2	none	varies	varies	B	47,568	
Quarters	B-1	179/311	WD	PS	AB	80,529	430,222
	B-2	1528	MAS	PS	AB	38,967	
	B-3	none	varies	varies	B	310,726	
Shops	C-1	313	WD	PS	AB	30,894	112,402
	C-2	1290	MAS	BU	AB	22,221	
	C-3	none	varies	varies	B	59,287	
Dining	D-1	179	WD	PS	AB	31,997	84,863
	D-2	820	MAS	BU	AB	18,176	
	D-3	none	varies	varies	B	34,690	
Latrines	E-1	821	MAS	BU	AB	19,573	28,445
	E-2	none	varies	varies	B	8,872	
Nonenergized	F-1	none	varies	varies	O	120,780	120,780
TOTAL BUILDING AREA							<u>947,550</u>

Wall Construction Code: WD - Wood or metal frame with wood siding, metal siding or brick veneer.
MAS - Masonry block or brick.

Roof Construction Code: PS - Pitched shingle over wood deck or metal roofing.
BU - Built-up roof over wood or metal deck.

Energized Systems Code: AB - Heating and non-heating systems.
B - Non-heating systems only.
O - No energized systems.

FORT A.P. HILL BUILDING USE-GROUP SUMMARY
FIGURE 1

FORT A.P. HILL CONSTRUCTION CHARACTERISTICS OF TYPICAL BUILDINGS

GROUP NO.	BUILD. NO.	BUILDING USE	NO. OF FLOORS	BUILDING AREA (FT ²)	ROOF TYPE AREA (FT ²)	U VALUE	WALL TYPE AREA (FT ²)	U VALUE	DOOR TYPE AREA (FT ²)	U VALUE	FLOOR TYPE PERIMETER (FT.)	U VALUE	WINDOW TYPE AREA (FT ²)	U VALUE
A-1	101	ADMIN.	1	5,080	ASPH SHGL	.043	STL SDG	.17	WOOD	.60	SLAB	-	STORM	.99
					5,080		2,314		126		347		335	
A-1	126	ADMIN.	1	2,490	ASPH SHGL	.043	STL SDG	.17	WOOD	.60	CRAWL	.63	STORM	.99
					2,490		2,139		42		2,490 FT		219	
A-1	214	ADMIN.	1	11,191*	ASPH SHGL	.25	STL SDG	.17	WOOD	.60	CRAWL	.63	STORM	.99
					11,191		5,007		126		11,191 FT		1,527	
B-1	179	BARRACKS	1	5,700	ASPH SHGL	.05	BRK/WDSOS	.17**	METAL	.60	SLAB	-	THERMAL	.99
					5,700		3,372		168		536		448	
B-1	311	BARRACKS	1	3,247	CGD STL	.07	CGD STL	.45	METAL	.60	SLAB	-	SGL GLZ	1.10
					3,247		3,991		126		454		423	
B-2	1,528	BARRACKS	1	7,563	ASPH SHGL	.07	CMU	.35	WOOD	.60	SLAB	-	SGL GLZ	1.10
					7,563		4,567		122		659		1,021	
C-1	313	SHOPS	1	5,234	CGD STL	.08	CGD STL	.45	METAL	.60	SLAB	-	SGL GLZ	1.10
					5,171		10,456		831		807		212	
C-2	1,290	SHOPS	1	9,306	BLT-UP	.074	CMU	.53	METAL	.60	SLAB	-	SGL GLZ	1.10
					9,306		6,964		1,896		545		1,128	
D-1	179	DINING	1	6,280	ASPH SHGL & BLT-UP	.03**	BRK/WDSOG	.10**	METAL	.60	SLAB	-	THERMAL	.99
					6,280		3,827		350		382		236	
D-2	820	DINING	1	6,176	BLT-UP	.067	CMU	.39	METAL	.60	SLAB	-	SGL GLZ	1.10
					6,176		4,028		119		404		228	
E-1	821	LATRINE	1	7,056	BLT-UP	.071	CMU	.39	METAL	.60	SLAB	-	SGL GLZ	1.10
					5,984		3,712		252		447		281	

* DOES NOT INCLUDE BASEMENT (NOT: HEATED, OCCUPIED, OR TYPICAL OF OTHER BUILDINGS)
 ** WEIGHTED AVERAGE

FORT A.P. HILL TYPICAL BUILDING SYSTEMS SUMMARY TABLE

GROUP NO.	BUILDING NO.	BUILDING USE	COOLING		HEATING		DOMESTIC HOT WATER		NORMAL PEAK OCCUPANCY	OCCUPANCY SCHEDULE
			SYSTEM TYPE	CAPACITY (TONS)	SYSTEM TYPE	FUEL	SYSTEM TYPE	FUEL		
A-1	101	ADMIN.	DX	10.8	FURNACE	#2 OIL	40 GAL.	ELEC.	16	0800-1630 (1630-0800 FOR DUTY OFFICER)
A-1	126	ADMIN.	DX	7.8	FURNACE	#2 OIL	40 GAL.	ELEC.	23	0700-1700 (OCCAS TO 2400 DURING NIGHT TRAINING)
A-1	214	ADMIN.	N/A	N/A	STOVES	#1 OIL	75 GAL.	LP GAS	VARIES	VARIES
B-1	179*	BARRACKS	AIR COOLED CHILLER	29.0	BOILER FAN/COIL	#2 OIL	750 GAL.	#2 OIL	49	24 HRS/DAY
B-1	311	BARRACKS	N/A	N/A	FURNACE	#2 OIL	100 GAL.	HEAT EXCH.	VARIES	VARIES
B-2	1,528	BARRACKS	N/A	N/A	FURNACE	#2 OIL	331 GAL.	HEAT EXCH.	VARIES	VARIES
C-1	313	SHOPS	N/A	N/A	FURNACE	#2 OIL	40 GAL.	ELEC.	12	24 HRS/DAY
C-2	1,290	SHOPS	WINDOW UNIT	-	BOILER FAN/COIL FAN RAD	#2 OIL	80 GAL.	ELEC.	12	0800-1630
D-1	179*	DINING	AIR COOLED CHILLER	29.0	BOILER FAN/COIL	#2 OIL	750 GAL.	#2 OIL	49	12 HRS/DAY - 7 DAYS/WK
D-2	820	DINING	N/A	N/A	BOILER FAN/COIL	#2 OIL	676 GAL.	#2 OIL	VARIES	VARIES
E-1	821	LATRINE	N/A	N/A	BOILER FAN/COIL	#2 OIL	775 GAL.	#2 OIL	VARIES	VARIES

* BLDG. 179 CONSISTS OF A 3-BLDG. COMPLEX, 2 IDENTICAL BARRACKS, AND 1 MESS HALL

FIGURE 3

BUILDING GROUP ENERGY USAGE

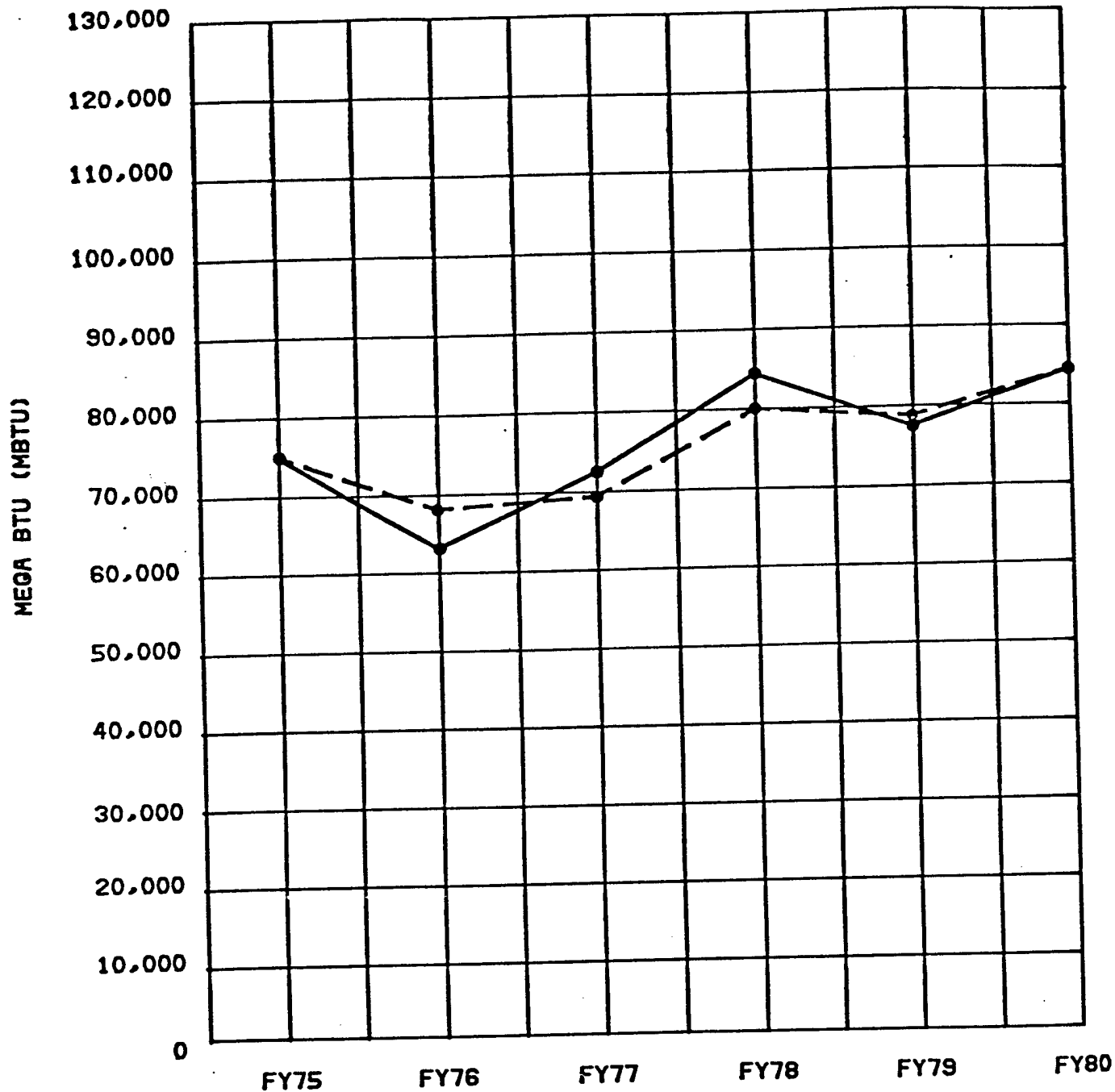
FORT A.P. HILL - 1975 - BASE YEAR

SUB-GROUP	STUDY BUILDING	Y/H	TOTAL GROUP SQ.-FT.	STUDY BUILDING GROUP AVERAGE BTU/FT ² -YR.			TOTAL BUILDING GROUP AVERAGE MBTU/YR.		
				ELECTRIC	FUEL	TOTAL	ELECTRIC	FUEL	TOTAL
A-1	101, 126 214	Y	88,248	57,948	114,309	172,257	5,114	10,088	15,202
		H	35,022	33,620	15,495	49,115	1,177	543	1,720
A-2	214	H	8,748	876	0	876	8	0	8
B-1	311, 179.B	Y	47,018	50,764	90,650	141,414	2,387	4,262	6,649
		H	24,424	29,316	15,529	44,845	716	379	1,095
B-2	1528	Y	38,967	62,964	123,417	186,381	2,454	7,263	9,717
C-1	313	Y	27,250	70,902	89,282	160,184	1,932	2,433	4,365
		H	3,644	37,791	6,057	43,848	138	22	160
C-2	1290	Y	3,315	102,396	38,513	140,909	339	128	467
C-3	313, 1290	H	62,887	42,581	6,139	48,720	2,678	386	3,064
D-1	179.D	Y	22,222	273,699	225,344	499,043	6,082	5,008	11,090

Y-DENOTES YEAR ROUND BUILDING USE
 H-DENOTES WINTERIZED BUILDINGS

FORT A. P. HILL - 1975 - BASE YEAR

[illegible]

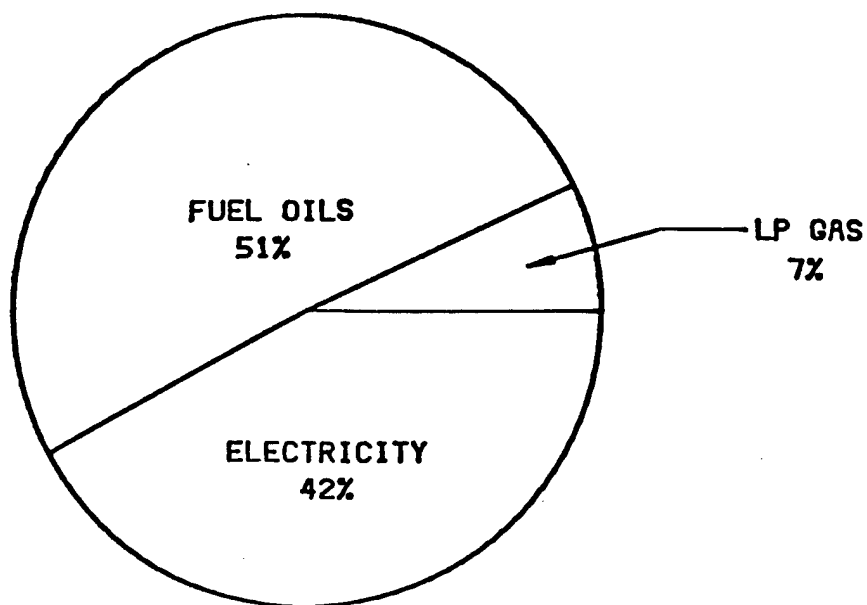


TOTAL ENERGY CONSUMPTION
FY75 THRU FY80
FORT A.P. HILL

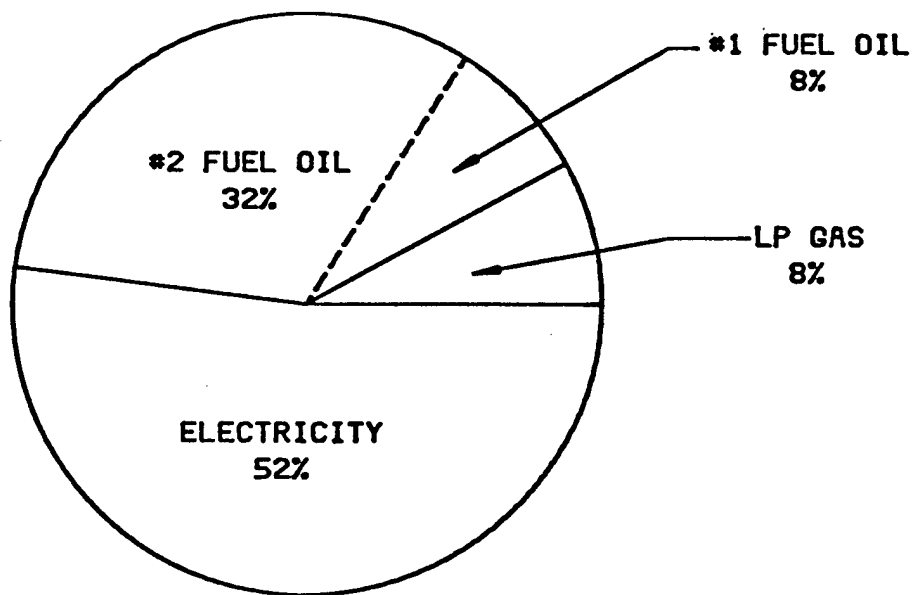
FIGURE 5

KEY
——— NORMALIZED FOR HDD & CDD
- - - TOTAL ENERGY

FY 1975
TOTAL ENERGY USE
75,244 MBTU PER YEAR



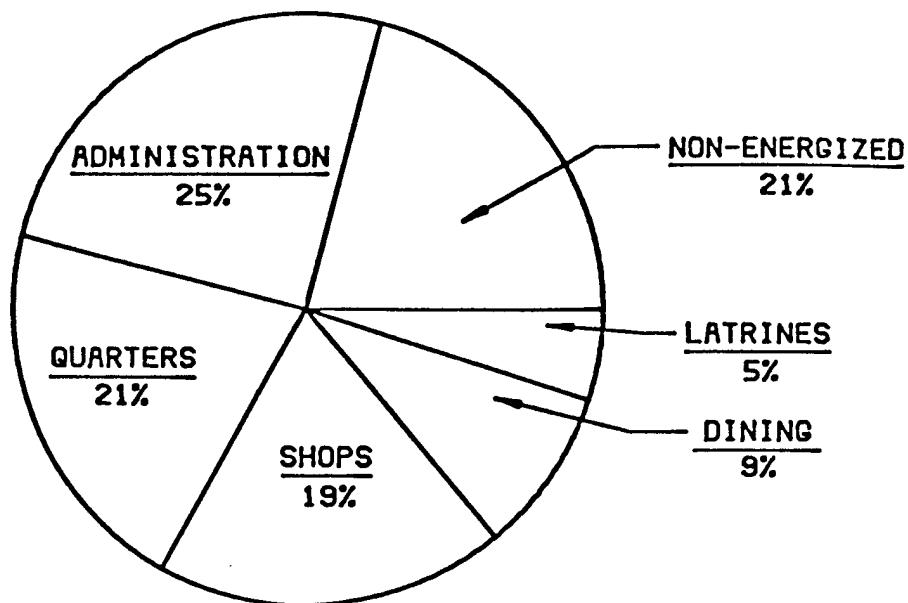
FY 1980
TOTAL ENERGY USE
86,054 MBTU PER YEAR



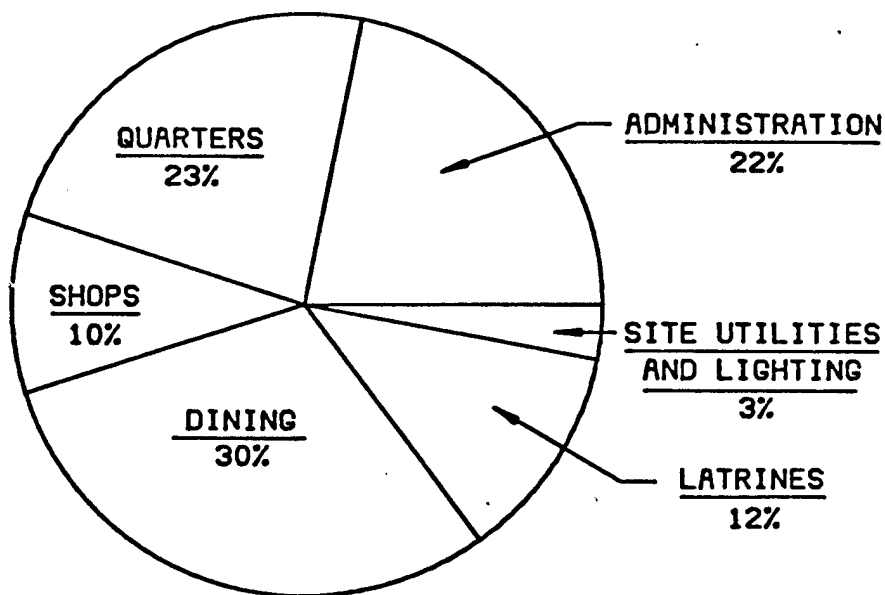
HISTORICAL FUEL BLEND FORT A.P. HILL

FIGURE 6

USE GROUP AREA
522,395 SQ. FT.



USE GROUP ENERGY
CONSUMPTION
75,240 MBTU



BUILDING USE GROUP AREA
AND ENERGY DISTRIBUTIONS

ENERGY ENGINEERING ANALYSIS PROGRAM
CONTRACT NO. DACA65-81-C-0021

X = GOOD OPTION
Y = FEASIBLE OPTION
(TO RECEIVE PRELIMINARY STUDY)
Z = POOR OPTION
(SEE COMMENTS)
O = NOT APPLICABLE
■ = USE GROUP BLDGS. (AGGREGATE AREA)
WITHOUT ENERGIZED HEATING SYSTEMS

[illegible]

BUILDING USE GROUP	SUB-GROUP	STUDY BLDG.	EX	IN	INC	MES	CEN	MAIL	ELEC	REAR	EARTH	TRO	OVR					WATER	HEAT
ADMINISTRATION	A-1	101	Y	Y	Z	X	X	Y	O	O	O	O	O					X	O
		126	Z	O	Z	X	Z	Y	Y	O	O	O	O					X	O
		214	Y	Z	O	X	X	Y	Y	O	O	O	O					O	O
	A-2	*	O	O	O	O	O	O	O	O	O	O					O	O	
QUARTERS	B-1	179	Z	O	Z	X	Z	Z	O	O	O	O					Z	O	
		311	Z	Z	X	X	Y	X	O	O	O	O	O					Y	Y
	B-2	1528	Z	Z	X	X	Y	X	O	X	Y	Y	O					Y	O
	B-3	*	O	O	O	O	O	O	O	O	O	O					O	O	
SHOPS	C-1	313	Z	Z	Y	X	Y	X	O	O	O	O	Y				X	O	
	C-2	1290	Z	Z	Y	X	Z	X	O	X	Y	Y	Y				X	O	
	C-3	*	O	O	O	O	O	O	O	O	O	O	O				O	O	
DINING	D-1	179	Y	O	Z	Z	Z	Z	O	O	O	O					Z	O	
	D-2	820	O	Z	X	X	Y	X	O	O	Y	Y	O				Y	O	
	D-3	*	O	O	O	O	O	O	O	O	O	O	O				O	O	
LATRINES	E-1	821	O	Z	O	X	Y	X	O	O	Y	Y	O				Y	O	
	E-2	*	O	O	O	O	O	O	O	O	O	O	O				O	O	
SITE UTILITIES & LTG.			O	O	O	O	O	O	O	O	O	O	O					O	O

PRELIMINARY MATRIX - ENERGY

EEA PROJECT SUMMARY

INC.	PROJECT	SIR	E/C RATIO	B/C RATIO	INSTALL. COST (#)	ANNUAL SAVINGS (MBTU)	PAYBACK (YRS.)
A	NIGHT SET-BACK	21.6	117.3	25.84	55,500	6,512	0.6
A	INEFFICIENT LIGHT FIXTURE REPLACEMENT	0.9	28.3	1.27	84,200	2,387	9.0
A	CEILING INSULATION	7.3	23.3	9.28	135,500	3,150	2.5
A	WOOD FRAME WALL INSULATION	6.3	20.3	8.01	108,100	2,195	3.0
A	EXTERIOR WALL INSULATION	4.3	14.3	5.45	273,700	3,901	4.3
B	INEFFICIENT SITE LIGHTING REPLACEMENT	1.3	14.1	1.74	80,400	1,136	10.4
A	CAULK AND WEATHERSTRIP	3.8	12.4	4.89	55,200	684	4.8
A	STORM WINDOWS	2.7	8.7	3.23	111,600	973	6.9
	TOTAL:	-	-	-	904,200	20,938	-

FIGURE 9

EEA PROJECT SUMMARY

[illegible]

EEA PROJECT SUMMARY

[illegible]

■ PER 100 FT² OF COLLECTOR

FIGURE 11

EEA PROJECT SUMMARY

INCREMENT	SAMPLE BUILDING PROJECT	E/C RATIO	B/C RATIO	INSTALL. COST (#)	ANNUAL SAVINGS (MBTU)	PAYBACK (YRS.)
F	PHOTO & CLOCK CONTROLS	113	7.90	640	72	1.2
F	FLOURESCENT LAMPS	35	1.14	11,900	418	5.0
F	LAMPS - BLDG. 101	11	1.5	2,500	27	12.3
F	EFFICIENT MOTORS	23	1.25	800	(14)	5.9
F	SELECTIVE SWITCHING	∞	∞	0	840	0.0
F	DHW CIRC. PUMP CONTROLS	43.4	4.5	219	(9.5)	3.1
F	INSULATED DAMPER PANELS	31	10.7	76	(2)	3.0
F	DHW ELIMINATION	1,370	222.0	15	(20)	0.1
F	REDUCED GLAZING	79	32.6	20	(2)	0.8
F	REPLACE OVERHEAD DOORS	37	15.8	3,300	(122)	1.6
F	FUTURE METERING PLAN	-	-	4,791	0	-
F	DWH INSULATION	41 TO 63	6.2 TO 16.3	57 TO 413	4 TO 17	1.5 TO 2.2
	TOTAL:				1,357	

() TOTAL SAVINGS COULD NOT BE QUANTIFIED

FIGURE 12

ENERGY COST PROJECTION

FISCAL YEAR	ESCALATED FUEL COST (\$/MBTU)*	
	ELECTRICITY	#2 FUEL OIL AND KEROSENE
1982	\$4.50	\$9.88
1983	4.84	11.11
1984	5.56	12.78
1985	6.40	14.70
1986	7.35	16.90
1987	8.46	19.44
* ESCALATED AS RECOMMENDED BY COE "ENERGY CONSERVATION INVESTMENT PROGRAM GUIDANCE", TABLE #2, AT 15% PER YEAR FOR FUEL OIL AND ELECTRICITY. SEE ALSO APPENDIX 3.5		

EEA130-0883/0103

ENERGY PROJECTION SUMMARY

ITEM	MBTU	PERCENT CHANGE
FY 1975 TOTAL ENERGY CONSUMPTION	75,243	0%
A. PAST ENERGY CONSERVATION PROJECTS	(-) 2,748	(-) 3.7%
B. ENERGY CONSERVATION PROJECTS UNDER CONTRACT	(-) 263	(-) 0.3%
■ ■ C. EXISTING OPERATIONAL & MAINTENANCE PROCEDURES	(+) 7,573	(+) 10.1%
D. DEMOLITION AND SHUTDOWN	0	0.0%
E. CONSTRUCTION PROJECTS	(+) 16,200	(+) 21.5%
■ F. RECOMMENDED ENERGY PROJECTS: INCREMENTS (A), (B) & (F)	(-) 22,295	(-) 29.6%
FY 1985 ENERGY CONSUMPTION PROJECTION	73,710	(-) 2.0%

■ NOTE: ENERGY SAVINGS RESULTING FROM SOME INCREMENT (F) PROJECTS COULD NOT BE PROJECTED. SEE FIGURE 3-10.

■ ■ NOTE: SEE SECTION 3.4 OF THE REPORT NARRATIVE FOR ADDITIONAL INFORMATION ON O & M PROCEDURES.